IRRIGATION WATER CONVEYANCE (Ft.)

Pipeline

Nonreinforced Concrete

Definition

A pipeline and appurtenances installed in an irrigation system.

Scope

This standard applies to low or intermediate pressure nonreinforced concrete irrigation pipelines with rubber gasket joints, mortar joints, or cast-in-place without joints.

The standard includes the design criteria and minimum installation requirements for nonreinforced concrete irrigation pipelines and the specifications for the concrete pipe to be used.

Purpose

To prevent erosion, degradation of water quality or damage to the land, to make possible the proper management of irrigation water, and to reduce water conveyance losses.

Conditions Where Practice Applies

All pipelines shall be planned and located to serve as integral parts of an irrigation water distribution or conveyance system that has been designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

Water supplies and irrigation deliveries for the area served shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be employed.

Concrete pipelines shall not be installed on sites where the sulfate salt concentration in the soil or soil water exceeds 1.0 percent. On sites where the sulfate concentration is more than 0.1 percent but not more than 1.0 percent, concrete pipe may be used only if the pipe is made with Type V cement or Type II cement whose tricalcium aluminate content does not exceed 5.5 percent.

Cast-in-place pipe shall be used only in stable soils that are capable of being used as the outside form for approximately the bottom half of the conduit.

Design Criteria

A. Pressure

1. Definition - Maximum working head is defined as the working head plus freeboard.

2. Rubber Gasket Joints - The maximum working head shall not be more than 1/3 the certified hydrostatic test pressure as determined by the hydrostatic test procedure as prescribed in ASTM C 505 and shall not exceed 50 feet for sizes 6 through 12 inches, 40 feet for sizes 15 through 18 inches, 30 feet for sizes 21 through 24 inches, and 25 feet for sizes 26 through 30 inches.

3. Mortar Joints - The maximum working head shall not be more than 1/4 the certified hydrostatic test pressure as determined by the hydro-static test procedure as prescribed in ASTM C 118 and shall not exceed 40 feet for sizes 6 and 8 inches, 35 feet for sizes 10 and 12 inches, 30 feet for sizes 14 through 24 inches, and 25 feet for sizes 26 through 30 inches.

4. Cast-in-Place Pipe - The maximum working head will not exceed 15 feet above the centerline of the pipe.

B. External Load Limit

A safety factor of at least 1.25 shall be applied to the 3-edge bearing test in computing allowable heights of fill over the precast pipe.

C. Capacity

Design capacity shall be based on whichever of the following is greater.

1. The capacity shall be sufficient to deliver the volume of water required to meet the design use rate of the crop.

2. The capacity shall be sufficient to provide an adequate irrigation stream for all methods of irrigation planned.

D. Outlets

Appurtenances to deliver water from the pipe system to the land, to a ditch, or to any surface pipe shall be known as outlets. Outlets shall have adequate capacity at design working pressure to deliver the required flow (1) to the hydraulic grade line of the pipe or ditch, or (2) to a point at least 6 inches above the field surface.

E. Friction Loss

For design purposes, friction head losses shall be no less than those computed by the Manning equation using a coefficient of roughness "n" of 0.011 for rubber gasket jointed pipe, 0.012 for mortar jointed pipe, and 0.014 for cast-in-place pipe.

F. Thrust Control

Abrupt changes in pipeline grade or alignment require either:

1. A stand of diameter greater than the pipeline.

2. A thrust block to absorb any axial thrust of the pipeline.

3. A larger diameter pipe placed horizontally or placed vertically and capped below ground or a capped below ground in-place structure.

An abrupt change shall be considered to be: (a) an angle of 45 degrees or greater when the maximum working head is under 10 feet; (b) an angle of 30 degrees or greater when the maximum working head is between 10 and 20 feet; and (c) an angle of 15 degrees or greater when the maximum working head is greater than 20 feet.

Where a vent is used in lieu of a pump stand at the entrance to a rubber gasket irrigation pipeline, a suitable anchor shall be constructed to resist end thrust.

Thrust blocks shall be constructed of either:

1. Concrete poured to fill the space between the pipe and the undisturbed earth at the side of the trench on the outside of bends.

2. Soil cement with at least one part of cement to 12 parts of soil of sandy loam or coarser texture, similarly placed and thoroughly tamped.

The thrust block shall be a minimum of the full height of the outside diameter of the pipe and shall have a minimum thickness of 6 inches and a length in feet normal to the direction of thrust equal to:

$$A = 98 (HD2/B) (\sin a/2)$$

where:

A = Area of thrust block,
H = Maximum working head in feet,
D = Inside diameter of the pipe in feet,
B = The allowable passive pressure of the soil in pounds square foot, and
a = The deflection angle of the pipe bend.

The pipe shall be clean and wet when placing the thrust block to provide a good bond between anchor and pipe. Where adequate soil tests are not available, the allowable passive soil pressure shall be considered to be 500 pounds per square foot.

G. Design of Pipelines Open to the Atmosphere

1. General - Stands shall be placed at each inlet to a concrete irrigation pipe system and at such other points as required. All stands shall serve as vents in addition to their other functions. Stands shall be supported on a base adequate to support the stand and prevent movement or undue stress on the pipeline.

   All stands will comply with the following:

   a. Avoid entrainment of air.

   b. Allow 1 to 5 feet of freeboard.

   c. Conform to ASTM C 76 or C 478 when concrete pipe of diameter greater than 24 inches is used.

   d. When cast in place, contain steel reinforcing on not more than 1-foot centers to provide steel areas equal to or greater than the least values specified for Class II (1500-D-Ultimate) pipe in ASTM C 76.

   e. Have tops at least 4 feet above the ground surface, except that if visibility is not a factor, the tops may be lower when covered or equipped with trash guards.

   f. Be of such dimensions that downward water velocities shall not exceed 2 feet per second, and

in no case shall downward velocities exceed the average pipeline velocity.

g. Be of a size and design to permit repairs and cleaning.

Check valves shall be installed in the pump discharge line where detrimental backflow from the pipeline can occur.

Construction shall be such as to insure that the vibration from the pump discharge pipe is not carried to the stand or pipeline.

2. Pump Stands:Pump stands shall be one of the following types:

a. Concrete box stands with vertical sides, suitably reinforced.

b. Non-tapered stands of concrete pipe, suitably reinforced.

c. Non-tapered concrete pipe stands, capped and having a vent pipe of the height required to take care of hydraulic gradient plus freeboard.

d. Steel cylinder stands mortared to short concrete pipe riser.

e. A vent in combination with a direct connection, in lieu of a pump stand, providing:

(1) The pipeline joints are rubber gasket type, exclusively;
(2) Freeboard requirements under General are met;
(3) The velocity, direction and turbulence of flow does not prevent the release through the vent of entrained air; and
(4) The discharge from the pump does not enter through the vent.

For pump stands of types 1, 2, 3 and 4 above, and when the pump discharge velocity exceeds 3 times the outlet velocity, the centerline of the pump discharge pipe shall have a minimum vertical offset from the centerline of the outlet pipe equal to the sum of the diameters of the inlet and outlet pipes. The pump discharge may enter through the side of the stand or over the top.

All pump stands having a decreased size above the pump discharge, and the vent of type 5 above, shall be of such a cross-sectional area that if the entire flow of

the pump were discharged out through the top of the stand or type 5 vent, the average velocity would not exceed 10 feet per second.

3. Gate Stands: Gate stands shall:

   a. Be constructed of concrete pipe or shall be cast-in-place. Reinforcing requirements listed under Stand Requirements will apply.

   b. Have dimensions sufficient to accommodate the gate or gates required.

   c. Serve as vents.

   d. Be of such dimensions that gates are accessible for repair.

4. Float Valve Stands

   Float valve stands shall be of sufficient diameter to provide accessibility for maintenance and to dampen surge.

5. Sand Traps

   Pump stands or gravity inlets serving as sand traps shall have a minimum inside diameter of 30 inches and shall be constructed so that the bottom is at least 24 inches below the invert of the outlet pipeline. Suitable provisions for cleaning sand traps shall be provided. The downward velocity of flow of the water in a sand trap shall not exceed 0.25 feet per second.

6. Vent Requirements

   Vents shall be designed into the system to provide for the removal of air and protection from surge. They shall:

   a. Have a minimum freeboard of 1 foot above the hydraulic gradeline. The maximum height of the vent above the centerline of the pipeline must not exceed the maximum working head of the pipe.

   b. Have a cross-sectional area at least one-half the cross-sectional area of the pipeline (both inside measurements) for a distance of at least 1 pipeline diameter up from the centerline of the pipeline. Above this elevation the vent may be reduced to 2 inches in diameter.

c. Be located:

(1) At the downstream end of each lateral.

(2) At summits in the line.

(3) At points where there are changes in grade in a downward direction of flow of more than 10 degrees.

(4) Immediately below any stand if the downward velocity in the stand exceeds 1 foot per second.

7. Air-Vacuum Release Valves

An air-vacuum release valve may be used in lieu of an open vent, but either a vent or an air-vacuum release valve shall be provided at each of the locations in item 3 of Vent Requirements, above. Air-vacuum release valve outlets shall have a 2-inch nominal minimum diameter. Two-inch outlets shall be used for lines of 6-inch diameter or less, 3-inch outlets for lines of 7-inch to 10-inch diameter, and 4-inch outlets for lines of 12-inch diameter.

Air release or vacuum release valves shall not be used in lieu of open stands nor shall they be used in lieu of a vent where the vent is used in combination with a direct pump connection.

H. Design of Pipelines Not Open to the Atmosphere

1. General: Pressure relief valves may be used on non-reinforced concrete pipelines as an alternative to design with stands open to the atmosphere. A pressure relief valve shall serve the pressure relief function of the open stand or vent for which it is an alternative.

Pressure relief valves do not function as air release valves and shall not be used as substitutes for such valves where release of entrapped air is required.

The flow capacity of pressure release valves shall be the pipeline design flow rate with a pipeline pressure no greater than 50 percent above the permissible working head for the pipe.

2. Marking and Setting: Pressure relief valves shall be marked with the pressure at which the valve starts to open. Adjustable pressure relief valves shall be sealed or otherwise altered to prevent changing of the adjustment from that marked on the valve.

3. Other Design: Air-vacuum release valves shall be used at each location specified in Vent Requirements, Pipelines Open to the Atmosphere. The size of the outlet for air-vacuum release valves shall be as specified in Air-vacuum Release Valves, Pipelines Open to the Atmosphere.

Design of check valves, vibration control, gate stands, and sand traps shall be as specified for Pipelines Open to the Atmosphere.